Physics 569 ESM: Emergent States of Matter

Nigel Goldenfeld

1. Course Information.

The course meets in Loomis Laboratory of Physics room 158 on Mondays and Wednesdays 9.30-10.50am. Makeup lectures may be necessary due to the travel schedule of the lecturer, and will be given on Fridays at noon-12.50pm in 158 LLP, but only when previously announced. Please keep this time free if possible.

My office hour is planned to be at 3pm on Wednesdays. I strongly encourage you to take advantage of this opportunity to talk about physics with me. Feel free to come and talk with me at other times too, although it may be necessary to make an appointment if I am busy or have a meeting in progress.

Office address: 3-113 ESB
Office phone: 3-8027
Email: nigel@uiuc.edu

Office hour: Wednesdays 3.00pm

Email is the best way to reach me. Please do not phone me at home under any circumstances.

Web site: http://guava.physics.uiuc.edu/∼nigel/courses/569

The web site will be used to post homework exercises. You also need to sign-in to the course email list so that I can email you announcements when necessary.

2. Grader.

Questions about the grading of homework assignments should be directed to the Grader in the first instance, and then, if necessary to me. I will announce further details about the grader in class.

Grader: Mr. Xianhao Xin
Office address: 4111 ESB
Email: xin2@illinois.edu

Office hour: Tuesday 2-3pm

3. Texts.

There is no text for the class, but a number of useful books are recommended. In addition, my notes are available from the class web site. The recommended books are ones that previous students in this course have found helpful, and these are:

(A) General references on spontaneous symmetry breaking, Landau theory and generalized elasticity theory.

- P. Chaikin and T. Lubensky *Principles of Condensed Matter Physics*.
- N. Goldenfeld *Lectures on Phase Transitions and the Renormalization Group*.
- L.H. Ryder *Quantum Field Theory*. There is no quantum field theory *per se* in the course, but some students liked the discussion of symmetry breaking in this book.
- A. Altland and Ben Simons. *Condensed Matter Field Theory*. This is an advanced book, but one of the best to learn about the modern approach to condensed matter theory, with many-body theory done by functional integral techniques, and a clear and readable presentation of many technical issues.
- Mehran Kardar. *Statistical Physics of Fields*. A clear and well-written introduction to modern ways to deal with collective phenomena in condensed matter physics.

(B) Off-diagonal long-range order and condensates

- J. Annett *Superconductivity, Superfluids and Condensates*.
- C.J. Pethick and H. Smith *Bose-Einstein Condensation in Dilute Gases*

(C) Superconductivity

- M. Tinkham *Introduction to Superconductivity*.

(D) Liquid Crystals

- P.G. de Gennes *The Physics of Liquid Crystals*.

(E) Quantum Hall Effects

- M. Stone *The Quantum Hall Effect*.

(F) Biological emergence

- S. Strogatz *Sync*
- C. R. Woese *On the evolution of cells*, Proc. Natl. Acad. Sci. USA **99**, 8742-7 (2002).

(G) Pattern Formation

- M. Cross and P. Hohenberg *Pattern Formation Outside of Equilibrium*, Reviews of Modern Physics **65**, 851-1112 (1993).

4. Assessment.

There will be several homework assignments, which should be handed in to the 569 box, situated in the corridor between the Loomis Laboratory and the Materials Research Laboratory.

5. Feedback. Please let me know if you have any suggestions or comments about the class. There is no point in waiting until the end of the semester, because by then it is too late for me to act on the suggestion.

6. Preparation.

You are strongly urged to review your quantum mechanics notes, so that you have a working knowledge of *second quantisation*. The first (but not for credit) homework assignment will be a second quantisation worksheet.

Recommended text for 2nd quantisation: Baym *Lectures on Quantum Mechanics*.